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Patent Claims

1. A method for automated application of self-adhesive film to bodywork parts, in which a film blank is gripped on the non-adhesive outer face at two opposite ends by means of suction grippers to which a vacuum can be applied, and is held stretched out, in which the film blank which is held stretched out is aligned accurately in position above the bodywork part to be bonded to and is adhesively bonded to it,
characterized in that
prefabricated, elongated paint film blanks (6) are provided in a configuration according to features a to c) for application of paint film, and in that the paint film blanks (6) which have been provided in this way are moved according to features d) to g) for automated application:

a) each prefabricated, elongated paint film blank (6) is included in a film composite (5, 15, 15', 16, 16') and is provided on the outside and underneath with an adherent but easily detachable protective strip (8, 9), with each of the two protective strips (8, 9) projecting (projections 10, 10', 11, 11') beyond the useful length (L) of the paint film blank (6) at the two ends, which are located in the area of the narrow faces of the paint film blank (6),

b) the length, measured in the longitudinal direction of the film blank (6), of the first projection (11, 11'), which is referred to in the following text as an "end projection", is approximately matched to the attachment width (b_2) of the associated suction gripper (31) measured in the longitudinal direction of the paint film blank (6)

while, in contrast, the length of the other projection (10, 10′), which is referred to in the following text as the "start-side projection", is likewise matched approximately to the attachment width (b_1) of the associated suction gripper (30) but with at least the lower protective strip (9) on the start-side projection (10, 10′) being lengthened by a specific gripping length (l) beyond said attachment width (b_1) (pulling-off lug 12, 12′),

c) the film composite (5, 15, 15′, 16, 16′) which is formed in this way and includes the paint film blank (6) is offered in a defined position with the outer protective strip (8) being freely accessible in the working area of a freely programmable industrial robot, which is provided with an application tool (20, 20′, 20′′), for picking up by the application tool (20, 20′, 20′′),

d) the film composite (5, 15, 15′, 16, 16′) is picked up by two suction grippers (30, 30′, 30′′, 31, 31′, 31′′), which are provided on the application tool (20, 20′, 20′′) and whose sucking picking-up surfaces (32) are located on a standard picking-up plane (21), on the upper protective strip (8) in the area of the two projections (10, 10′, 11, 11′), with the two suction grippers (30, 30′, 30′′, 31, 31′, 31′′) then being pivoted from the picking-up plane (21) through a respective specific angle (α, α'), in such a way that the projections (10, 10′, 11, 11′) which have been picked up of the film composite (5, 15, 15′, 16, 16′) that is held stretched out project obliquely and approximately in mirror-image form with respect to one another from the picking-up plane (21) in the direction of the rear face (23) of the application tool (20, 20′, 20′′),

e) the lower protective strip (9) is pulled off,

starting from the start-side end of the paint film blank (6) and guided by the start-side projection (10, 10′), which is used as a pulling-off lug (12, 12′) and is gripped by a gripping tool (50, 50′, 80, 80′), which can move within the application tool (20, 20′, 20′′) thus exposing the adhesive face of the paint film blank (6),

f) once the film composite (5, 15, 15′, 16, 16′), which is held stretched out by the application tool (20, 20′, 20′′) has been aligned in the correct orientation at a short distance from the bodywork part (1), which is to be bonded to and is held firmly in the defined orientation and inflexibly, the paint film blank (6) is wiped onto the bodywork part (1) to be bonded to, from the stretched-out separated position, by means of a flexible wiper (90, 91) which can move longitudinally within the application tool (20, 20′, 20′′),

g) the upper protective strip (8) is then pulled off the outer face of the applied paint film blank (6) by means of a pulling-off movement of the application tool (20, 20′, 20′′), in particular of the end suction gripper (31, 31′, 31′′).

2. The method as claimed in claim 1,
characterized in that
the pivoting movement of the two suction grippers (30, 30′, 30′′, 31, 31′, 31′′) takes place in such a manner that the tensile stress in the picked-up film composite (5, 15, 15′, 16, 16′) is changed no more than negligibly by the pivoting movement.

3. The method as claimed in claim 1,
characterized in that
the magnitude of the pivoting angle (α, α') of the suction grippers (30, 30′, 30′′, 31, 31′, 31′′) is greater than the largest angle (β) which occurs during

the application process between the film composite (5, 15, 15', 16, 16') on the one hand and the connecting line between the two boundary edges (33, 33'), which are located on the picking-up plane (21), of the opposite suction grippers (30, 30', 30'', 31, 31', 31'') on the other hand.

4. The method as claimed in claim 1, characterized in that a supporting film (7) which corresponds to the thickness of the paint film (6), is in each case inserted between the two protective strips (8, 9) in the area of the projections (10, 11), so that the film composite (5, 15, 15') is formed with three layers over its entire length - apart from certain interruptions - and has a uniform thickness (D) and in that the film composites (5, 15, 15') are offered in a stacked form.

5. The method as claimed in claim 4, characterized in that the film composites (5, 15, 15') are offered stacked at least in an approximately horizontal position.

6. The method as claimed in claim 1, characterized in that, at the start of the application process, the lower protective strip (9) is pulled off only partially and the adhesive face of the paint film blank (6) is initially only partially exposed, and in that the rest of the process of pulling off the lower protective strip (9) and exposure of the adhesive face of the paint film blank (6) are carried out corresponding to the progress of the process of wiping the paint film blank (6) onto the bodywork part (1).

7. The method as claimed in claim 1, characterized in that the paint film blank (6) is wiped onto the bodywork

part (1) in only a single direction and with only one wiper (90, 91).

8. The method as claimed in claim 1, characterized in that, during the wiping on process, an approximately constant distance (A) is maintained between the progressing wiper (90, 91) on the one hand and the likewise progressing pulling-off point on the lower protective strip (9) that is to be pulled off.

9. The method as claimed in claim 1, characterized in that the process of pulling off the lower protective strip (9) is carried out by the superimposition on the one hand of a translational movement of a winding device, which winds up the lower protective strip (9) and is moved at a speed which matches the speed of the wiper, and on the other hand by a winding movement of the winding device, with the winding device - in its own right - likewise winding up the pulled-off protective strip (9) at a speed which matches the speed of the wiper (90, 91).

10. The method as claimed in claim 1, characterized in that the end suction gripper (31, 31', 31'') approaches the bodywork surface (1) to be bonded over towards the end of the wiping-on process.

11. The method as claimed in claim 1, characterized in that the end projection (11, 11') of the film composite (5, 15, 15', 16, 16') which is gripped by the end suction gripper (31, 31', 31'') is allowed to continue sliding towards the end of the wiping-on process.

12. The method as claimed in claim 1, characterized in that

the wiping-on process is carried out with a linear pressure of between 10 and 50 N/cm, preferably between 20 and 30 N/cm.

13. The method as claimed in claim 1, characterized in that the paint film blank (6) is wiped on by means of a wiper (91) composed of a hard felt with a thickness of about 10 to 20 mm.

14. The method as claimed in claim 1, characterized in that, in order to pull the outer protective strip (8) off the completely applied paint film blank (6), the application tool (20, 20', 20'') is pivoted away from the bodywork surface (1) about a virtual pivoting axis which is located in the vicinity of one of the suction grippers (30, 30', 30'', 31, 31', 31''), preferably in the vicinity of the start-side suction gripper (30, 30', 30''), and/or is moved in the direction of the opposite end of the paint film blank (6) such that the suction gripper (31, 31', 31'') which has been moved away pulls the outer protective strip (8) off the applied paint film blank (6).

15. An apparatus for automated application of self-adhesive film to bodywork parts, comprising an application tool which can be handled by a freely programmable industrial robot and which has two suction grippers, which are arranged at a distance from one another and to which air or a vacuum can be applied deliberately, on the one flat face, which is referred to in the following text as the "working face" of the application tool, which suction grippers can grip one film blank at two opposite ends on the non-adhesive outer face and can hold it stretched out, such that the film blank can be handled freely by the industrial robot in the stretched-out state, in particular in

order to carry out the method as claimed in claim 1, characterized in that,

for the application of elongated, prefabricated paint film blanks (6), which are in each case included in a film composite (5, 15, 15', 16, 16') which is designed to be suitable for automation and is produced on an individual basis, the application tool (20, 20', 20'') is provided with the following features:

a) the two suction grippers (30, 30', 30'', 31, 31', 31'') are each arranged in the application tool (20, 20', 20'') such that they can pivot and are provided with a pivoting drive (37, 40, 40') such that the suction grippers (30, 30', 30'', 31, 31', 31'') can be pivoted with their sucking picking-up surface (32) onto a standard picking-up plane (21) - the picking-up position - in order to transfer a paint film composite (5, 15, 15', 16, 16') which has been provided, or can be pivoted to a working position, which positions are approximately in mirror-image form with respect to one another, and in which working position the sucking picking-up surfaces (32) project from the standard picking-up plane (21) in the direction of the flat face of the application tool (20, 20', 20'') which is opposite the working face (22) and is referred to in the following text as the "rear face" (23),

b) a gripping tool (50, 50', 80, 80') which can be moved parallel is arranged adjacent to one of the suction grippers, which is referred to in the following text as the "start suction gripper" (30, 30', 30''), and this gripping tool (50, 50', 80, 80') can on the one hand be moved onto the picking-up plane (21) alongside the start suction gripper (30, 30', 30'') such that it is ready to pick up, and on the other hand can be moved from this start position under the picking-up plane (21) to a working plane (53) and, furthermore, on the working plane (53) parallel to the working

plane (53) and parallel to itself (50, 50', 80, 80'),

c) furthermore, a wiper (90, 91) is arranged within the application tool (20, 20', 20''), can be moved with its working edge from a waiting position, in which it has been moved back from the picking-up plane (21), to a working position in which it is located close to the picking-up plane (21), can be pressed on with a specific force, and in this position can be moved in a straight line and parallel to the picking-up plane (21).

16. The apparatus as claimed in claim 15, characterized by
a horizontal stacking platform (96) which is mounted elastically, is arranged in the working area of the industrial robot that is handling the application tool (20, 20', 20''), and has side holding and guide webs (97, 98), on which the film composites (5, 15, 15') are offered at least approximately in a horizontal position to the application tool (20, 20', 20'') in a stacked form (95).

17. The apparatus as claimed in claim 16, characterized in that
the stacking platform (96) is held at a variable height and is provided with a controllable (109, 110) height adjustment drive (105 to 108), in such a way that the upper edge of the stack (95) is always at a constant height position, irrespective of the number of film composites (5, 15, 15') in the stack (95).

18. The apparatus as claimed in claim 15, characterized in that
the pivoting axes (34) of the two suction grippers (30, 31) are located on the picking-up plane (21) and close to that boundary edge (33, 33') of the suction grippers (30, 31) which faces the paint film blank (6), such

that the tensile stress in the picked-up film composite (5, 15, 15', 16, 16') is changed no more than negligibly by a pivoting movement of the suction grippers (30, 31).

19. The apparatus as claimed in claim 15, characterized by the totality of the following features:

a) the pivoting bearing (34'', 35'') of the start-side suction gripper (30'') is in the form of a conventional journal bearing, whose center point is offset with respect to the picking-up plane (21) of the application tool (20'') in the direction of its rear face (23) to such an extent that those outlines of the journal bearing (35'') which are closest to the picking-up plane (21) are themselves still offset with respect to the picking-up plane (21) of the application tool (20'') in the direction of its rear face (23),

b) the pivoting bearing for the end suction gripper (31'') is in the form of a four-bar linkage with two rockers (45, 45') which are each articulated on the one hand on the end suction gripper (31'') and are each articulated on the other hand the application tool (20''), with the moving instantaneous center of rotation (46, 46') for the pivoting movement of the end suction gripper (31'') which is caused by this being offset in all of its positions with respect to the picking-up plane (21) of the application tool (20'') in the opposite direction to the journal bearing (34'', 35''),

c) the four-bar linkage bearing for the end suction gripper (31'') is designed with respect to the mutual arrangement of the hinge points and the length of the rockers (45, 45') such that the position offset (distance h'), which results from the pivoting, of the boundary edge (33') of the

end suction gripper (31'') close to the blank is of the same size, in terms of its magnitude and direction, as the corresponding position offset (distance h') of the start-side suction gripper (30'').

20. The apparatus as claimed in claim 15, characterized in that the suction grippers (30, 30', 30'', 31, 31', 31'') can pivot through a fixed pivoting angle (α, α') which can be predetermined by stops (38, 39; 38', 39'; 43, 44; 43', 44'; 47, 48; 47', 48') in the order of magnitude of 10 to 45°, preferably 15 to 30°.

21. The apparatus as claimed in claim 15, characterized in that the gripping tool (50, 50', 80, 80') is mounted such that it can rotate and is designed so that it can be driven to rotate, and has an approximately constant, approximately round cross section over its longitudinal extent, such that it can at the same time be used as a coil core for a material which is in the form of a strip and is gripped by the gripping tool (50, 50', 80, 80') at the end.

22. The apparatus as claimed in claim 15 or 21, characterized in that the gripping tool is in the form of long-nose pliers (50, 50') which can move within the application tool and have an upper jaw part (51, 51') which is arranged above the picking-up plane (21), at least in the initial position in which it is ready to pick up - and have a lower jaw part (52, 52'), which is arranged underneath the picking-up plane (21), wherein only the lower jaw part (52, 52') can move, in the sense of an opening and closing movement of the long-nose pliers (50, 50').

23. The apparatus as claimed in claim 22, characterized in that the lower jaw part (52) can be pivoted through 90° in the sense of an opening and closing movement of the long-nose pliers (50), such that, in the initial position of the long-nose pliers (50), in which they are completely open and are ready to pick up, the lower jaw part (52) projects at right angles to the picking-up plane (21) and away from the application tool (20, 20', 20'').

24. The apparatus as claimed in claim 22, characterized in that, in the sense of an opening and closing movement of the long-nose pliers (50'), the lower jaw part (52') can be moved parallel to itself in the closing sense towards the upper jaw part (51'), and can be moved away from it in the opening sense, and in that the long-nose pliers (50') as an entity can be moved out of and into the area of the film composite (5, 15, 15', 16, 16') to be picked up from the side and transversely with respect to its longitudinal extent, wherein the distance (transverse distance Hq) through which the gripping tool (50') can be moved corresponds at least to the width of the film composite (5, 15, 15', 16, 16') to be picked up.

25. The apparatus as claimed in claim 24, characterized in that the gripping tool (50'), which can be driven to rotate and is at the same time used as a coil core for the lower protective strip (9) is held in a spindle (71) which itself is mounted such that it can move axially in a hollow shaft (70) which is mounted such that it can rotate and can be driven to rotate, and is coupled to a linear movement drive (77), wherein the closing and opening movement of the gripping tool (50') is derived from the axial movement of the spindle (70).

26. The apparatus as claimed in claim 15, characterized in that the gripping tool (80, 80'), which can be driven to rotate and is at the same time used as a coil core for the lower protective strip (9), is in the form of a suction strip (80, 80'), which can move within the application tool (20, 20', 20'') and to which air or a vacuum can be applied in a controlled manner, which suction strip (80, 80') has an approximately semicircular or D-shaped cross section, has a sucking contact surface (88, 88') on the flat face, and whose contact surface (88, 88') can be applied to the start-side projection (12, 12') of the film composite (5, 15, 15', 16, 16') that is held in the application tool (20, 20', 20'').

27. The apparatus as claimed in claim 15, characterized in that the gripping tool (50, 50', 80, 80'), which can be driven to rotate and is at the same time used as a coil core for the lower protective strip (9), can be moved deliberately to a rotation position such that the picking-up surface (51'', 88, 88') of the gripping tool (50, 50', 80, 80') is ready to pick up parallel to the start-side projection (12, 12') of the film composite (5, 15, 15', 16, 16') which is held in the application tool (20, 20', 20'').

28. The apparatus as claimed in claim 15, characterized in that the rotation speed of the rotary drive of the gripping tool (50, 50', 80, 80') which is used at the same time as a coil core can be controlled during the winding process such that an at least approximately constant circumferential speed of the coil (68) which can be predetermined, can be maintained irrespective of an increasing diameter of the coil (68).

29. The apparatus as claimed in claim 15, characterized in that the wiper (90, 91) and the gripping tool (50, 50', 80, 80') are connected to one another, or are coupled to one another and can be moved at the same speed, with a fixed association (distance A) in the working position.

30. The apparatus as claimed in claim 15, characterized in that the intensity of the vacuum during the time in which it can be applied can be varied separately at least for the end suction gripper (31, 31', 31'') such that the fixing force can be varied towards the end of the wiping-on process in the sense of allowing it to continue to slide.

31. The apparatus as claimed in claim 15, characterized in that the wiper (90, 91) can be pressed onto the film blank (6) and/or onto the bodywork part (1) which is held inflexibly with a linear pressure amounting to 10 to 50 N/cm, preferably 20 to 30 N/cm.

32. The apparatus as claimed in claim 15, characterized in that the wiper (91) is composed of a hard felt with a thickness of about 10 to 20 mm.

33. An elongated, prefabricated paint film composite which is intended for application to specific bodywork parts, in which the usable paint film blank is provided both on the outside and underneath with an adherent but easily detachable protective strip, characterized in that, for automated application of the paint film blank (6) by means of an application tool (20, 20', 20''), which can be handled by means of a programmable industrial

robot, to the film composite (5, 15, 15', 16, 16'), both the outer protective strip (8) and the lower protective strip (9) each project beyond the paint film blank (6) at the two ends which are located in the area of the narrow faces of the paint film blank (6), wherein the length, measured in the longitudinal direction of the film blank (6), of the one projection (11, 11'), which is referred to in the following text as an "end projection", is approximately matched to the attachment width (b2) of the associated suction gripper (31, 31', 31'') measured in the longitudinal direction of the paint film blank (6) while, in contrast, the length of the other projection (10, 10'), which is referred to in the following text as the "start-side projection" is likewise matched approximately to the attachment width (b_1) of the associated suction gripper (30, 30', 30'') wherein, however, at least the lower protective strip (9) is lengthened beyond the said attachment width (b_1) on the start-side projection (10, 10') by a specific gripping length (l) in order to be gripped by a protective strip pulling-off apparatus (gripping tools 50, 50', 80, 80').

34. The paint film composite as claimed in claim 33, characterized in that,
a supporting film (7) which corresponds to the thickness of the paint film (6), is in each case inserted between the two protective strips (8, 9) in the area of the projections (10, 10', 11, 11') of the protective strips (8, 9), such that the film composite (5, 15, 15', 16, 16') has three layers over the entire length of at least the outer protective strip (8) - apart from certain narrow interruptions (13) - and to this extent has a uniform thickness (D).

35. The paint film composite as claimed in claim 34, characterized in that,
in the area of the start-side projection (10) the upper

protective strip (8) is also lengthened by the gripping length (l) beyond said attachment width (b_1) and is connected to the lengthened (pulling-off lug 12) lower protective strip (9) with a supporting film (7) inserted between them, and in that the upper protective strip (8) and the supporting film (7) are slotted at the same point and over the entire width of the film composite (5) along a line which runs transversely with respect to the longitudinal direction of the film composite (5) and which is located in the area between the start-side projection (10) and the pulling-off lug (12) around said gripping length (l) while, in contrast, the lower protective strip (9) is also continuous at this point.

36. The paint film composite as claimed in claim 33, characterized in that
the supporting film (7) is identical to the paint film (6) but is separated from the usable part of the paint film blank (6) by an interruption (13).

37. The paint film composite as claimed in claim 33, characterized in that
the lower protective strip (9) is provided with an antistick coating such that it is easier to detach the lower protective strip (9) from the adhesive face of the paint film blank (6) than to detach the latter (6) from the outer protective strip (8).